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STATUS OF AN OUTBREAK OF A WESTERN BUDWORM, CHORISTONEURA CARNANA CALIFORNICA, ON THE WEAVERVILLE RANGER DISTRICT, SHASTA-TRINITY NATIONAL FORESTS - 1985

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ABSTRACT

A western budworm, Choristoneura carnana californica Powell, again defoliated Douglas-firs in 1985 over 130,000 acres of mixed ownership within the boundaries of the Weaverville District, Shasta-Trinity National Forests, but damage was greatly reduced. The low efficacy of the treatment of 88,000 infested acres with Bacillus thuringiensis did not explain the improved foliage retention in 1985, nor did a driving, cold spring rainstorm fully account for the decrease in defoliation. Egg mass counts averaged 0.4/m^2 of foliage -- an indication of mostly light damage for 1986. One new infestation of 400 acres was found at Bear Creek near Meter Meadow. Damage in Deadwood Gulch and Big Gulch did not continue. Life history of the budworm and parasites are briefly discussed.

INTRODUCTION

A western budworm, Choristoneura carnana californica Powell, has damaged Douglas-firs on part of the Weaverville Ranger District of the Shasta-Trinity National Forests since 1981. The first report of damage was given in the spring of 1982. A chronological reconstruction of the outbreak indicates that about 5500 acres of host type were damaged in 1981, 33,000 acres in 1982, 93,000 in 1983, and 130,000 in 1984 (Dale 1983, 1984a,b).

An outbreak of this budworm was historically unprecedented, so the potential longevity of the infestation was unknown. Therefore, the consensus of the managers of the affected lands was to monitor the insect population and the effects of defoliation on the host type through 1983. This decision was supported by a sharp decline in the number of egg masses/m^2 of foliage in 1983. However, heavy defoliation continued in several areas in 1984 and the increase in the number of egg masses/m^2 suggested additional heavy feeding injury in 1985 (Dale 1984b).

The Shasta-Trinity National Forests, in cooperation with the other land managers, prepared an environmental assessment (EA) in the winter of 1984 that estimated the cost of controlling the outbreak would be greater than the

projected value of the damage that would be prevented by treatment. This changed in the winter of 1985 when the major private landowner accelerated harvest plans and the benefit/cost comparison for private lands became strongly positive. At that time the land managers agreed to a cooperative control project for 88,000 acres with the California Department of Forestry as lead agency. In May 1985 this acreage was treated with Bacillus thuringiensis (Bactospeine™) by two fixed-wing turbo aircraft at 12 BIU/acre.

The Insect - Choristoneura carnana californica

This budworm has been collected in the Coast Range of California as far south as Santa Cruz County. It also has been taken from Douglas-firs in Lake and Napa Counties and along the southern Cascade Range and the Sierran west slope as far south as El Dorado County (Powell 1980). The adult moths are brick red and heavily marked with white on the forewing. Markings vary from distinct to mottled bands. Wing spans range from 19 to 25 mm.

The moths usually emerge from the pupal stage from mid-June through early July (Fig. 1). However, in early spring years, such as 1985, moths may appear by the end of May and flight will cease by the end of June. Light green eggs are laid in masses on the underside of needles during this period. Within a short time the larvae develop and hatch from the eggs. The newly hatched larvae do not feed, but rather seek protection among lichens and bark scales, where they remain in silken-shelters from July to late March or early April of the following year.

When weather conditions become suitable in the spring, the larvae mine into developing male and female flowers. When this preferable food source is scarce or absent, they mine in the tips of old needles until the vegetative buds begin to swell, whereupon they transfer to these buds. It is thought that young larvae do not develop rapidly on older needles and that survival rates decline when this food source must be utilized. Larvae show a preference for new foliage throughout the spring. However, older needles are eaten by later stage larvae if the population strips the new foliage. Larvae develop rapidly, and population suppression measures usually would take place in late May or early June. In an early year such as 1985 however, it was necessary to begin suppression on May 11 and the project of 88,000 acres was completed on May 24[1].

SURVEYS

Pre- and Post-treatment Larval Populations

Locations from past samplings were used for pre- and post-treatment larval sampling (Dale 1984a,b). Sixteen locations occurred in untreated areas and 76 occurred in treated areas. Personnel for crews were supplied by Forest Pest Management, California Department of Forestry, Bureau of Land Management, Santa Fe Pacific Timber Company and Paul Bunyan Timber Company. Pre-treatment sampling began on May 9 and continued until the unit was sprayed. Post-treatment sampling occurred 10 to 14 days after treatment. Non-treatment areas

1. Project Report -- Budworm Control Project Fiscal Year 1984-85, Trinity Zone of Infestation. California Department of Forestry, Sierra Cascade Region, 6105 Airport Road, Redding, CA 96002.

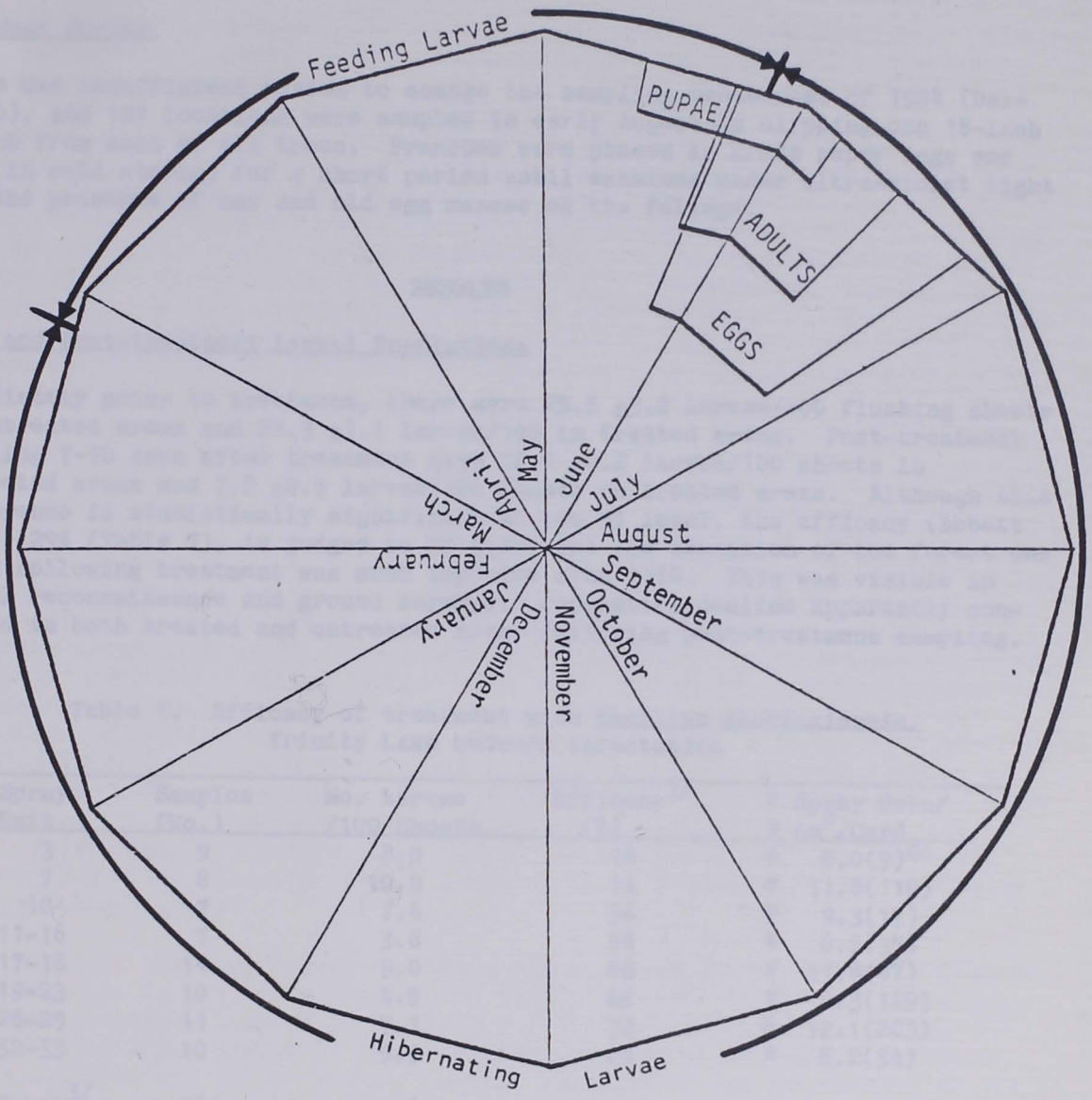


Figure 1. General representation of the seasonal occurrence of the budworm, Choristoneura carnana californica Powell, in the vicinity of Clair Engle (Trinity) Lake, Trinity and Shasta Counties, Californica.

were sampled at the same time as contiguous treated areas. One 18-inch branch was clipped into a pole-mounted catch-bag from the mid-crown of six different Douglas-firs 25-45 ft in height. Branches and larvae were taken to a temporary laboratory for examination in pre-treatment sampling, but post-treatment examinations were made in the field on a drop-cloth. All larvae were retained for developmental evaluation in the laboratory in both sampling periods.

Egg Mass Survey

There was insufficient reason to change the sampling procedures of 1984 (Dale 1984b), and 127 locations were sampled in early August by clipping one 18-inch branch from each of six trees. Branches were placed in kraft paper bags and kept in cold storage for a short period until examined under ultra-violet light for the presence of new and old egg masses on the foliage.

RESULTS

Pre- and Post-treatment Larval Populations

Immediately prior to treatment, there were 25.5 ±3.2 larvae/100 flushing shoots in untreated areas and 21.3 ±1.1 larvae/100 in treated areas. Post-treatment sampling 7-10 days after treatment gave 12.0 ±2.2 larvae/100 shoots in untreated areas and 7.2 ±0.5 larvae/100 shoots on treated areas. Although this difference is statistically significant at the 5% level, the efficacy (Abbott 1925), 29% (Table 1), is judged to be poor; yet the condition of the forest one month following treatment was much improved over 1984. This was visible in aerial reconnaissance and ground surveys. Population decline apparently continued in both treated and untreated areas following post-treatment sampling.

Table 1. Efficacy of treatment with Bacillus thuringiensis, Trinity Lake budworm infestation

Spray Unit	Samples (No.)	No. Larvae /100 Shoots	Efficacy[1] (%)	Spray Dots/ cm²/Card[2]
3	9	8.0	18	5.0(9)
7	8	10.8	11	11.8(110)
10	7	7.6	36	9.3(17)
11-16	7	3.6	68	6.5(35)
6,17-18	14	9.0	05	11.8(87)
19-23	10	4.5	62	9.3(129)
26-29	11	7.1	32	12.1(203)
32-33	10	5.9	24	8.2(34)
Total[3]	76	7.2	29	10.5(624)

1. Larval mortality in sprayed areas adjusted for natural mortality in nonsprayed areas
2. (): Total number of cards, Project Report, Trinity Zone of Infestation.
3. As calculated from the individual field data and not from the unit averages.

A post-treatment level of less than 5 larvae per 100 shoots was set as a measure of successful treatment. Suppression to or below this level was judged necessary to limit the ability of the surviving population to rebound to pre-treatment levels in one year. This was achieved in spray units 11-16 and 19-23 and at 25 of the 76 sample locations. However, only two locations had fewer than 1.5 larvae per 100 shoots, a level necessary for 85% efficacy.

The number of spray droplets per square cm per card averaged above 10. However, the greatest levels of spray deposit did not correspond with the best results in population reduction.

The lowest efficacy was for units 6,17-18 -- the area sprayed on the last day of treatment. The absence of effect may be the result of the heavy rain that began 72 hours after spraying finished and continued intermittantly for 24 hours. This explanation seems reasonable as the spray trail was seen settling into the canopy in such areas as Bragdon Gulch and the average droplet count was one of the higher levels recorded (Table 1). However, the rain may not account fully for the presence or absence of desired efficacy levels because untreated locations sampled prior to the rainstorm had fewer larvae than untreated locations sampled after the rainstorm -- 10 larvae/100 shoots:14.6 larvae/100 shoots.

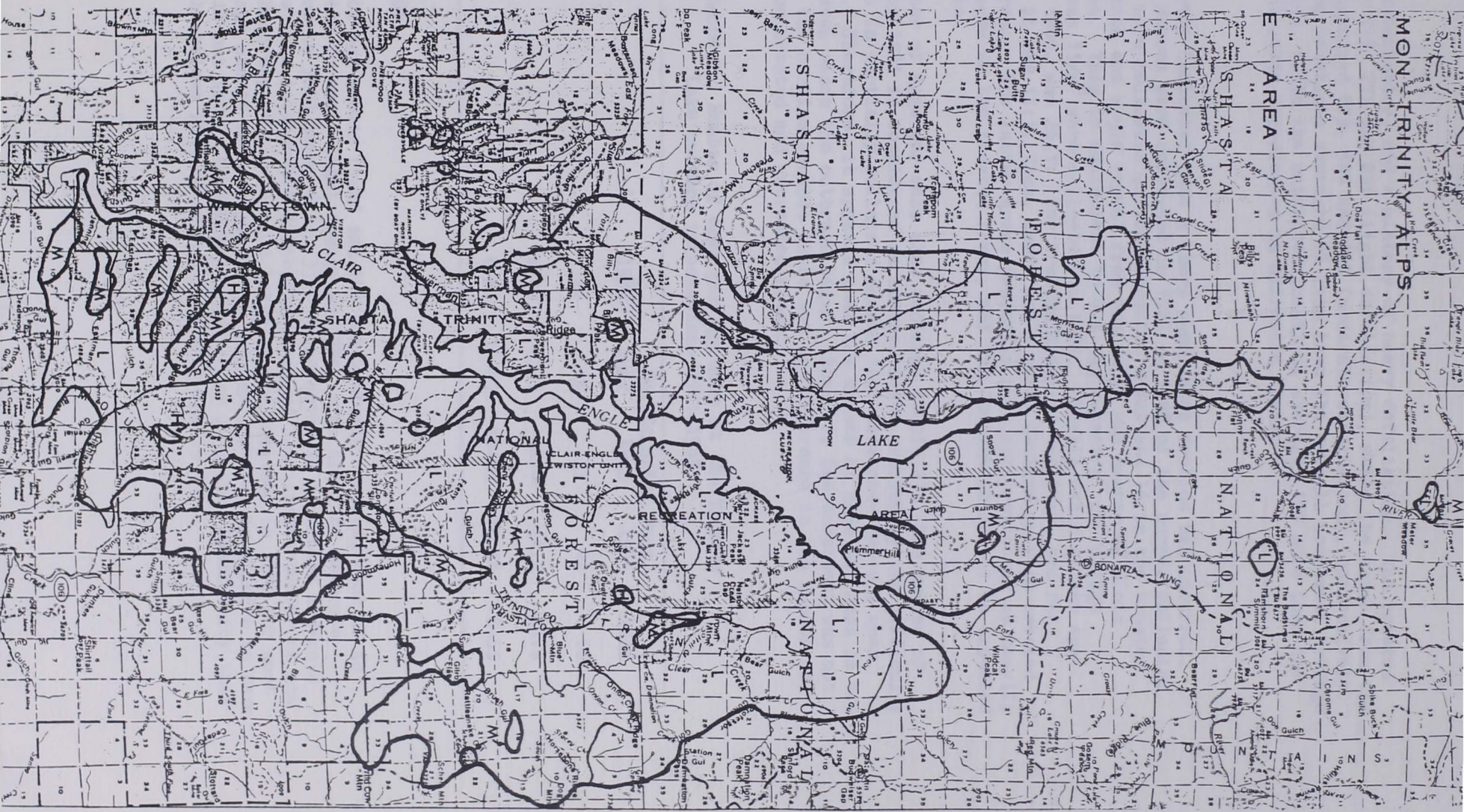
Area Infested

Aerial reconnaissance and ground surveys indicated that the infestation remained at approximately 130,000 acres (Fig. 2). A new spot infestation of 400 acres appeared on Bear Creek near Meter Meadow, while spot infestations disappeared in the untreated areas of Deadwood Gulch and Big Gulch. Aerial reconnaissance also indicated little visual difference between treated and untreated areas on June 26. Within the untreated areas, only Jennings Gulch and two small areas near Trinity Dam had sufficient damage to be aerially visible. Defoliation occurred primarily in mid- and lower-crown levels. Upper crown levels were generally undamaged, and defoliation visible from the air appeared as faint halos below green tops. Much of this damage was already visible to ground crews before treatment occurred. Heavy defoliation was limited to a few acres (Fig. 2), while moderate defoliation was limited to about 8% of the area. This acreage comprised about 12% of the untreated area and 6% of the treated area. The remaining 92% of the area would presently be classified as lightly damaged in 1985.

Examination of branches collected during the egg mass survey served to further illustrate the impact of treatment. Of 96 sample sites in the treated area, 66% were classed as lightly defoliated, 31% as moderate and 3% as heavy. In the untreated area, 35% of 31 sample sites were classed as lightly infested, 42% as moderate and 23% as heavy. Average defoliation was 29% (light) in the treated areas and 45% (moderate) in the untreated areas. The untreated areas averaged only 2.3% less than predicted (Dale 1984b) while defoliation in the treated areas was 21% less than expected. The difference between the aerial survey and the ground survey lies in the difference in defoliation between the upper one-third of the crown and the middle one-third.

A further comparison of foliar protection was made in October from three pairs of treated and untreated samples. A sample consisted of 25 apical shoots taken from two branches from six trees. The locations were matched by similarity of

Figure 2. Trinity Lake budworm infestation, Weaverville District, Shasta-Trinity National Forests, 1985. L = light, M = moderate, H = heavy defoliation. //// Boundary, National Recreation Area. Heavy line = infestation boundary, thin line = boundary of treatment with Bacillus thuringiensis, May 1985.



site, host characteristics, and a history of heavy defoliation. The treated samples averaged 19%, 27% and 23% (light defoliation), while the match from the untreated area averaged 67%, 53% and 60% (moderate defoliation), respectively. The three treated locations averaged 6% less than the overall treatment average of 29% defoliation, while the untreated locations averaged 15% more than the overall 45% defoliation experienced in untreated areas.

Egg Mass Survey

The egg mass survey indicated that a sharp population decline had occurred. Only 24 new egg masses were collected in 1985 -- 1.9% of the number collected in 1984. Eight were collected in the untreated areas and 16 in the treated units, a proportion one would expect from the acres and number of plots involved for each. This is equivalent to 0.4 egg masses/m^2 of foliage collected; whereas 11/m^2 were collected in 1984. Overall ratio of new egg masses, 1984 to 1985, was 26:1. For treated areas it was 34:1, and for untreated areas it was 11:1. Thus, there was a great decline in both treated and untreated areas. The latter areas generally were not previously as heavily infested or damaged as the treated areas, and the decline could not be expected to be so dramatic.

The average number of eggs per mass also declined (Table 2). The number of eggs per mass for 1981 is considered an underestimate created by the difficulty in counting eggs in partially collapsed masses that were one-year-old when counted in 1982. Therefore, it appears that the number of eggs per mass is now at the lowest level since the outbreak began. However, the treatment was not responsible for the decline because there was no difference in the number of eggs per mass for treated and untreated areas.

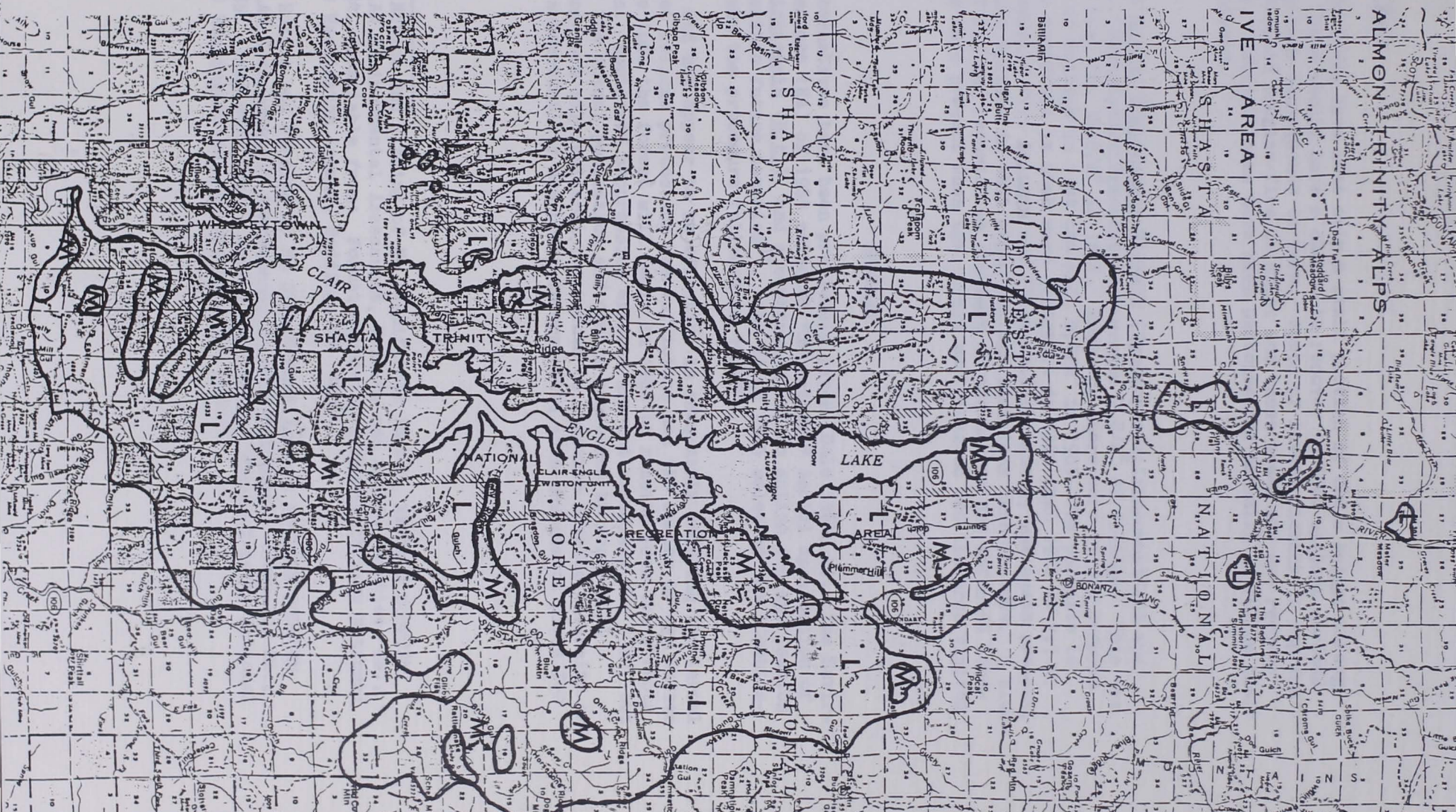
Table 2. Number of eggs per egg mass at the Trinity Lake budworm infestation, 1981-1985

	No. Eggs/Egg Mass				
	1981	1982	1983	1984	1985
Average	26	45	37	42	28
Std. error	±3.8	±3.9	±2.6	±4.2	±2.9
Range	8-62	15-91	10-81	15-94	8-59

Prospect for 1986

The low number of egg masses found and the subjectively observed decline in abundance of moths forecast light damage in 1986, with spots of moderate defoliation of up to 3000 acres (Fig. 3). Those areas of predicted moderate defoliation have been interpreted liberally based on the limited number of new masses found. Recovery of the damaged trees should continue in 1986 for most of the new foliage should be retained. The area of infestation appears to have stabilized and is not likely to increase, and there is a good possibility that the acreage with obvious feeding injury will decrease in 1986.

Figure 3. Predicted defoliation for 1986, Trinity Lake budworm infestation, Weaverville District, Shasta-Trinity National Forests. L = light, M = moderate, H = heavy defoliation. //// Boundary, National Recreation Area.



Status of the Host

Most defoliated trees have lost only a small protion of their height through top dieback. These should have a chance to recover in 1986 without serious defect or long-term consequence to form. Spots of severe dieback to sapling and small pole-sized Douglas-firs do exist and these trees may not recover satisfactorily. Several trees have been photographed annually to follow their decline or recovery.

Parasites

The cocoons of Glypta fumiferanae Viereck (Hymenoptera:Ichneumonidae) and Apanteles spp. (Hymenoptera:Braconidae) averaged 2.8/m^2 of foliage. This was markedly less than the 12.5/m^2 in 1984. However, there were 11 new budworm egg masses/m^2 of foliage in 1984 and only 0.4/m^2 in 1985. The parasite to egg mass ratio therefore is much more favorable in 1985 than 1984 -- 7:1 v. 1.1:1. The Tachinid fly, Aplomya sp. (Diptera:Tachinidae), was again present, but a subjective opinion is that abundance was much less than in 1984. A blue-bottle type of fly was reported as abundant in mid-May in one infested location, but none were present when the report was received and the area visited in June.

SUMMARY

Management alternatives have been previously given (Dale 1984a,b). The Environmental Assessment (EA) of 1984 selected "No Action," Aerial Application of Bacillus thuringiensis (B.t.), and a combination of no action and application of B.t. as possible future senarios[1]. The EA of 1985 selected the "Combination," which was the procedure followed in 1985[2].

The treatment did not appear to be effective in adequately reducing the larval population, yet foliage protection was sufficient and the number of egg masses found indicate that the forest will begin in 1986 to recover from the effects of defoliation. Continued suppression efforts are not necessary for 1986, but monitoring of the insect population and damage sustained by hosts will continue. Long-term silvicultural treatments to increase species diversity and reduce stand susceptibility are being incorporated into management plans for the area.

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